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TOBACCO CURING

W. W. GARNER

Physiologist in Charge of Tobacco and Plant-Nutrition Investigations, Bureau of Plant Industry

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TOBACCO CURING.

INTRODUCTION.

The curing of tobacco involves many complex changes in the composition and properties of the leaf which are not fully understood, but some of the more important principles of good curing are well established, and every grower should acquaint himself as far as practicable with the nature of these fundamental facts. Experience is essential in this as in other features of tobacco culture, but it is also true that the better the grower understands the nature of the changes going on in the leaf during the curing and the most favorable conditions for bringing about these changes the easier it will be for him to adopt the right methods for securing the desired results.

One of the characteristics of the tobacco industry is the fact that there are a large number of distinct types of tobacco produced, and the methods of curing often differ radically as applied to these different types. There are two distinct methods of harvesting tobacco, but aside from this there are three essentially different ways of carrying out the curing. These are (1) air curing, in which little or no artificial heat is applied; (2) flue curing, in which the tobacco is entirely cured by artificial heat and in such way as to prevent smoke from coming in contact with the leaf; and (3) fire curing, in which the tobacco is largely cured by artificial heat applied by means of open fires made on the floor of the barn, thus allowing smoke to come in contact with the leaf. It will be necessary to consider separately each of these methods, together with the modifications made in them in curing the various types of tobacco.

THE RIPENING OF TOBACCO.

In all cases the first requirement for good curing is that the tobacco be harvested when "ripe." The young growing leaf has a deep green color, showing that it is quite rich in the nitrogenous constituents which go to make up the living or vital part of the leaf and which are active in building up the food supply of the plant. At about the time the leaves of the plant as a whole have reached their maximum power of manufacturing this food supply, the flower head begins to

develop, and the food supply, consisting of starch and other substances, is carried from the leaf through the stalk into the seed head to furnish the necessary food for the development of the seed. In practice, however, the plant is topped, so that the seeds are not allowed to develop. Topping has the effect of causing secondary shoots, or suckers, to grow from the axils of the leaves, and these shoots will abstract food materials from the leaves, so that it is necessary that they be removed by the grower. Under these circumstances the food built up by the leaves is not carried into the stalk to any considerable extent, but accumulates in the leaves themselves. The result is that both the size and body or thickness of the leaf are increased. The surplus food supply which accumulates in the leaf, largely in the form of starch, replaces in part the green coloring matters, thus causing the appearance of a lighter shade of green and of the light-tinted flecks characteristic of the ripe leaf. The accumulation of the starchy material in the leaf also causes it to become brittle, so that it snaps when folded between the fingers—another sign of ripeness. This replacement of the green coloring matter by the starchy material has a most important effect on the color, aroma, elasticity, and finish of the cured leaf. Much of the success in curing tobacco depends on harvesting it at just the right time, when it is neither too ripe nor too green. The degree of ripeness, however, which the leaf must attain to secure the best results in curing varies greatly, depending on the type of tobacco grown.

NATURE OF THE CURING PROCESS.

If a ripe leaf of tobacco is quickly dried with heat it does not show the desirable properties of cured tobacco, so that curing is not simply drying out the leaf, but it involves other important changes in composition which can take place only under certain favorable conditions. Again, if a fresh leaf is exposed in a closed vessel to the vapors of chloroform or formaldehyde for a few minutes and then placed in the curing barn it can not be made to cure properly. The effect of the chloroform or formaldehyde is to kill the leaf quickly; hence, we see that prematurely killing the leaf prevents curing, or, in other words, curing is largely a living or vital process. The surplus supply of food which the leaf accumulates during the ripening period enables it to continue to live for several days after being harvested. When this reserve food supply is exhausted the leaf dies and is then nearly cured.

Curing, then, is forcing the leaves to undergo a process of gradual starvation under proper conditions. Anything which kills the leaf prematurely, such as bruising or breaking in harvesting, freezing, or very rapid drying, will prevent good curing. Moreover, the leaf,

when harvested, contains a large quantity of water, most of which is lost during the curing, and the rate of drying has an important effect on the result of the curing.

CURING PICKED LEAVES COMPARED WITH CURING ON THE STALK.

There are two general methods of harvesting the tobacco crop and of arranging it in the barn. In one method the leaves are picked from the stalk as they ripen and are arranged on strings or sticks suitable for hanging in the curing shed, while in the other the leaves are not removed from the stalks, but the latter are cut off near the ground and hung up in the barn, with the tips downward. The leaves on the plant do not all ripen at the same time, so that the stalks are cut at such a time as will give the greatest number of the best leaves at the proper stage of ripeness. This causes a considerable sacrifice in both bottom and top leaves, since the former are overripe and the latter still immature, but this process saves labor. In many cases both methods give satisfactory results when properly carried out, and the question as to which is the better in any given case must be decided largely by the local conditions, such as the amount and kind of the labor supply, the barn space available, and the like, as well as by the relative value of the crop to be cured. Much of the highest priced tobacco is now being cured after the leaves have been picked from the stalk by the method generally spoken of as "priming."

Although either method may give good results, there are undoubtedly differences in the yield and character of the cured product. To understand the differences brought about by the two methods, it must be remembered that the leaves and the stalks remain alive for several days, or even weeks, after harvesting, depending on the conditions in the curing barn. During this period of gradual starvation they are enabled to remain alive by means of the reserve food supply stored up during the ripening process, so long as they retain sufficient moisture. The loss in weight of the dry matter of the leaf as a direct result of the starvation process usually amounts to from 12 to 20 per cent in either method.

When the leaves are cured on the stalk there is a further loss in weight from another cause. It has been pointed out that while the plant is growing in the field there is a movement of food materials from the leaves into the stalk, and exactly the same thing happens in the curing barn when the tobacco is harvested by cutting the stalk. When the leaves are primed, there is, of course, no chance for this movement from leaf to stalk to take place. The result is that leaves cured by priming are 10 to 12 per cent heavier than if cured on the stalk. It has also been found that if suckers are left on the stalk at

the time of harvesting, there is a still greater loss of weight in curing the entire plant. But this is not all, for when the lower leaves are picked from the plant it causes those left on the stalk to increase in size and weight, so that altogether there is a gain in weight of fully 20 to 25 per cent when the tobacco is harvested by picking the leaves from the stalk.

The longer curing period and the movement of materials from the leaf into the stalk, when curing on the stalk is practiced, also affect the quality of the cured tobacco. Other things being equal, the picked leaves will have more of the so-called "oil" or "gum," greater elasticity, and more body than those cured on the stalk. Which method gives the better quality must be determined separately for the different classes or types of tobacco.

The above-mentioned facts apply more particularly to the usual methods of harvesting and curing cigar tobacco. In most of the manufacturing and export districts the greater portion of the stalk is split open in harvesting, which greatly shortens its life in the barn, and in flue curing the life of the stalk is further shortened by the higher temperatures used, so that there is less opportunity for the transfer of food materials from the leaf to the stalk. Under these circumstances there is less difference in yield and quality of cured leaf between priming and curing on the stalk. The applications of the two methods of harvesting are considered in detail in later paragraphs of this bulletin relating to the curing of the various types.

AIR CURING.

Nearly all the cigar tobaccos, wherever produced, the immense quantities of Burley and other manufacturing tobaccos grown in Kentucky and adjoining States, the Maryland export, and the Virginia sun-cured types are all air cured; that is, they are cured without the use of artificial heat except, in some cases, during periods of wet weather. The tobacco is placed in the barn in the ripened state, usually after having been wilted, and the curing is controlled simply by regulating the ventilation.

During the first stage of curing, while the leaf is undergoing starvation, it is also gradually losing the water which it contains, and one of the most important features of the curing is to properly regulate the rate of drying. If the leaf is dried too rapidly it is killed prematurely, and the curing is stopped, while if the rate of drying is too slow the curing goes too far. The rate of drying depends principally on the humidity in the barn. The fully ripe leaf is very rich in starch, and one of the important changes in the curing is the disappearance of this starch, which is consumed largely by the living portion of the leaf itself. If the leaf is killed by bruising, rapid drying, or heating too high there is no means of removing this

starch, and the tobacco is harsh, lifeless, and "strawy." Some of the nitrogenous constituents are also changed during this starvation period. These are the first changes necessary for curing. Along with these changes in composition the green color is replaced by a lemon yellow. If, by bruising or rapid drying out, the green leaf is killed outright soon after harvesting, the green color can not be removed by any later treatment the leaf may receive; but if the leaf remains alive two or three days under good curing conditions, any green color then remaining may be removed by sweating or fermentation.

The full development of the yellow color marks the end of the first period of the curing. The changes taking place in the second stage are for the most part quite different from those occurring in the first stage of the curing. After the leaf is dead no more of the starch is consumed, nor are the insoluble nitrogen compounds further changed. One of the most important changes in the second stage is the change in color from yellow to brown or red, which is caused by a process of oxidation that does not take place till the cells of the leaf are dead. The two conditions necessary for the development of the brown color are a supply of air and sufficient moisture. In air curing the principal danger is that the change will go too far, because of excessive moisture, causing the tobacco to cure too dark.

As regards quantity, the most important change in the curing is the loss of water. The tobacco leaf ordinarily loses about 75 per cent of its green weight in curing, and by far the greater portion of this loss is water. Thus, the tobacco from an acre yielding 1,800 pounds of cured leaf weighs when harvested something like 8 tons, including the stalks. Of these 8 tons fully 6 tons are water. To cure tobacco successfully this vast quantity of water must be removed under such conditions and at such a rate as will best allow the other important changes to take place.

CONDITIONS MOST FAVORABLE FOR AIR CURING.

The living cells of the leaf are killed by excessively low or high temperatures and by loss of water. In practice the most favorable temperatures for the first stage of air curing lie between 70° and 100° F., and the relative humidity should be about 85 per cent. Under these conditions the leaf will gradually lose its water, but will not become brittle, and the curing will proceed smoothly. If the humidity becomes much higher, pole-sweat will develop on the leaves most advanced in the curing, while if the humidity falls much below this figure the leaf will dry out too rapidly. In the second stage of the curing, when the leaf begins to turn brown, there is no longer any need for keeping the air in the barn so moist, and the leaf should be allowed to dry rather rapidly until the stems have become brittle.

It is desirable to prevent the tobacco from coming into very high "case"—that is, from becoming very moist, after curing and before it is taken down—so it should be stripped and assorted as soon as possible after the curing is completed.

Unfortunately, growers at the present time have very limited means of controlling the temperature and humidity in the barn in the air-curing process. If the season is too dry the tobacco "hays down"—that is, simply dries out like hay—while if it is too wet the tobacco is also seriously damaged.

Serious damage to the tobacco crop results annually from lack of means for maintaining the proper conditions in the barn during the curing period, and this loss can never be overcome until satisfactory methods are provided for conducting the cure independently of outside weather conditions. All experienced tobacco growers are aware of the serious damage likely to result from pole-sweat, or house-burn, during periods of very wet weather, but few fully appreciate the extent of the injury in quality caused by the opposite extreme of excessively dry weather.

POLE-SWEAT, OR HOUSE-BURN.

Pole-sweat, or house-burn, which is especially to be looked for during periods of prolonged wet weather, accompanied by rather high temperatures, occurs the world over where tobacco is cured without the use of heat. It is caused by minute organisms, which attack those parts of the leaf that give it toughness and stiffness, causing it to soften and decay. Pole-sweat does not occur until after the leaf tissue dies, but, of course, some parts of the leaf may die much sooner than others, so that the disease may appear before the entire leaf is dead. The organisms which cause this trouble are not active at very low temperatures, so that pole-sweat does not appear to any extent in cold weather. Furthermore, they thrive only in the presence of an abundance of moisture. The three necessary conditions for the rapid spread of the disease, then, are (1) tobacco which has passed through the first stage of the cure or which has been killed by bruising or other injury, (2) a temperature ranging from 60° to 100° F., and (3) a relative humidity of 90 per cent or more, which checks the evaporation from the leaves, causing them to become soggy. Of course, conditions favorable to pole-sweat may exist for short periods without the appearance of the disease, but it will certainly develop if these conditions continue for 24 to 48 hours. There is no doubt that the remedy for this trouble lies in controlling the humidity in the curing barn during periods of excessively damp weather, and the only practicable means of accomplishing this is by using artificial heat. This subject is considered in the discussion of methods of curing cigar tobaccos.

EFFECT OF HEAT AND VENTILATION.

Air curing, pure and simple, gives satisfactory results only when weather conditions are favorable. When the weather is unfavorable, more or less artificial heat must be applied to insure success. At the time the tobacco is hung in the barn water is evaporating from the surface of the leaves, and this evaporation continues until the surrounding space is saturated with moisture. Hence, the evaporation from the fresh leaves will soon cease unless the moisture is removed by circulation of the air. In moderately dry weather ventilation is all that is needed to secure favorable curing conditions, provided the temperature is not too low. In very dry weather the evaporation from the leaves can be kept in check by having the barn built as tight as possible and by keeping the ventilators closed during the day. If the temperature is low, the curing changes are stopped, although the tobacco may continue to dry out. In this case the leaf is simply dried and not cured.

During rainy or foggy weather the air is practically saturated with moisture, and since it can not take up any more, ventilation alone is useless under these circumstances. The capacity of the air in a given space for holding moisture is greatly influenced by the temperature, and by raising the temperature about 20° F. we double the capacity for holding moisture. In wet weather artificial heat is required to reduce the humidity in the barn. With suitable means of maintaining the temperature in the barn from 15° to 20° F. higher than that of the outside air, combined with proper ventilation, the problem of controlling the curing conditions is solved. An insufficient quantity of heat is worse than none, and enough must be supplied to warm the barn to the top and thus drive out the moisture. When the temperature is below 50° F. heat is needed for good curing regardless of the humidity, for while the tobacco may dry, it can not cure properly at low temperatures. Available methods of applying artificial heat in air curing are presented in the paragraphs relating to cigar tobaccos.

CURING CIGAR TOBACCOS.

The bulk of the cigar-tobacco crop at the present time is grown in Massachusetts, Connecticut, New York, Pennsylvania, Wisconsin, Ohio, Florida, and Georgia. The finest grades of wrapper leaf are grown in the Connecticut Valley and in a few counties of western Florida and southern Georgia, while Wisconsin is known as a binder State, and New York, Pennsylvania, and Ohio mainly produce filler grades. All cigar tobaccos are air cured, and the general methods of procedure are essentially the same in all the States that grow cigar tobacco. Artificial heat is being used more and more, however, in curing the wrapper types.

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CONSTRUCTION OF BARNS.

In building a good barn the two principal considerations to be kept in mind are to construct it as nearly air tight as possible and at the same time to provide a good system of ventilation. A site should be chosen which is thoroughly drained and sufficiently removed from other buildings to allow free access of air. It should be as near the tobacco field as possible for convenience in harvesting. The width of barns may range from 30 to 40 feet, and they may be of any convenient length up to 300 feet or even more, but the shorter barns are preferable. The interior should consist of a framework carrying poles for supporting the laths bearing the tobacco. The spaces between the poles are called tiers. Many barns are built four tiers high, but the curing can be better controlled when the building is only three tiers high to the plate. The tobacco should not hang

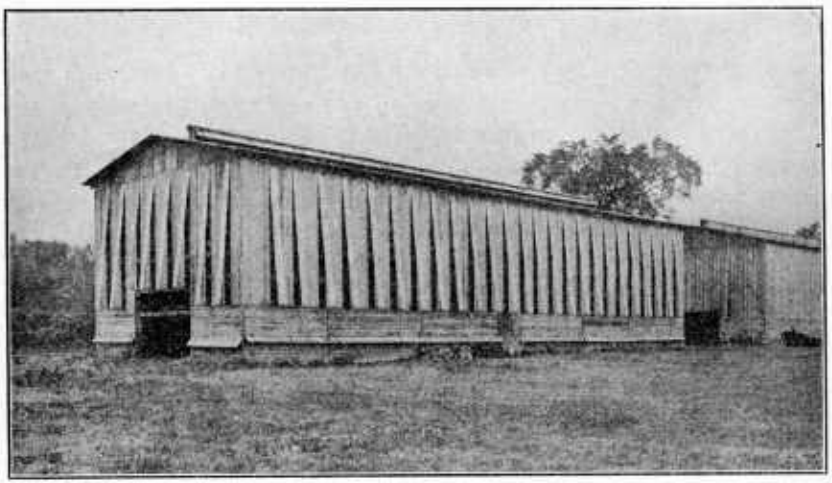

FIG. 1.—A good type of barn for curing cigar tobacco, with ventilators along the peak of the roof, adapted to the use of heat in curing.

within 3 feet of the ground, so that the first tier of poles should be at least 7 to 9 feet from the ground and the other tiers 4 to 6 feet apart.

The posts, plates, and beams used for the frame of the barn should be of stout timbers securely braced to carry the enormous weight of the green tobacco and to withstand heavy winds. In the usual type of barn, the posts, frames, and girders are set up across the barn at intervals of about 16 feet the same as at the ends, thus dividing the framework into sections known as "bents." The girders on the ends and on the bents for carrying the lower tier of poles usually are made removable, while those for the upper tiers should be well braced. The tier poles on which the tobacco is hung are usually about 16 feet long, and should be stout enough to carry at least 800 pounds. The horizontal distance between the poles should be 4 feet. The boards

for the sides and ends of the barn should be of uniform width, and all cracks should be battened with thin strips so as to make the structure as nearly weatherproof as possible. At least every third board should be hung on hinges as a ventilator.[1] The siding may be put on either vertically or horizontally, and there are numerous ways of arranging the ventilators. If the boards are put on horizontally, those used for ventilators should be hung from the upper edge, while if the siding is put on vertically those boards used for ventilators may be hung either from the top or side. Extending along the entire length of the sides a horizontal ventilator should be provided at the bottom for admitting air near the ground. Comparatively few barns at the present time have any provision for ventilation in the roof, such as is shown in figure 1, but this is an important feature in applying artificial heat when the weather is unfavorable.

The barn usually has driveways extending through it, and doors are provided at each end of sufficient size to allow a team to be driven through without difficulty. The construction of the barns used for curing cigar leaf in the southern districts is essentially the same as that of the barns in northern districts, except that the ventilators usually consist of openings at intervals of about 8 feet, 2½ to 3 feet wide and 10 feet long, with shutters suspended at or near the top. A good type of barn fitted with a system of vertical ventilators is shown in figure 1.

MANAGEMENT OF THE CURING.

The greater portion of the cigar tobaccos are cured with the leaves attached to the stalk, although in the wrapper sections harvesting by priming or picking the leaves from the stalk has recently become popular. The curing of picked leaves is discussed further in connection with the curing of shade-grown tobacco. The first step in curing is the thorough wilting of the leaves, for tests have shown that this promotes good curing. If the weather is cold or wet, it is desirable to apply artificial heat to hasten the wilting, and if the weather continues unfavorable the heat should be kept up for two or three days. Sufficient ventilation to take off the excess moisture must be provided. On the other hand, a too rapid drying out of the leaf must be avoided. Many growers in their anxiety to avoid damage from pole-sweat, caused by excessive moisture, injure their tobacco seriously by going to the other extreme of drying out the leaf so rapidly as not to allow sufficient time for those changes to take place that are essential to good curing. The aim should be to wilt the leaf as soon as possible and then to check the drying, but also to maintain a warm temperature until the leaf yellows. If no heat is applied, ventilation alone must be relied on to secure these conditions.

[1] It is assumed that the boards are 10 or 12 inches wide.

As soon as the yellow color begins to develop, the drying should be hastened, for the development of the brown color, which soon follows, indicates that the leaf is beginning to die, and this is the critical stage in the cure. If the humidity remains very high at this stage for any considerable period, pole-sweat will develop, which is to be especially feared if a season of warm, damp weather sets in. The only remedy lies in the use of artificial heat to keep down the humidity. Whether or not heat has been used in the first stages, it is absolutely necessary to prevent damage under the severe conditions of pole-sweat and must be kept up until the leaf is pretty well dried out. Ventilation alone will be of little value.

Aside from the danger of pole-sweat, however, there are other important reasons why the humidity in the barn should be reduced as soon as the brown color begins to develop. At the present time the demand is for bright colors in wrapper leaf, and the longer the second stage of the cure is protracted by a relatively high humidity the darker the leaf will be. Again, each time the tobacco comes into high case, after the cure is finished, the color will be further deepened. Finally, if the tobacco at this stage remains moist for a long period, it undergoes a sort of cold sweat and does not ferment so well when put in the case or in bulk. After the cure is finished, the tobacco should be prevented from coming into high case or order until it is to be taken down, as far as this is possible. Sunlight injures the color of tobacco; hence, the sun should not be allowed to shine on the leaf in the barn. Wind may bruise the leaves near the doors and ventilators, unless these are carefully watched and regulated.

The time required for completing the cure varies from five to eight weeks, depending on weather conditions. Quick curing may be depended on to give the best results, provided the first stage is not unduly hastened. The cure is finished when the midrib of the leaf is dried out so that it will snap when bent between the fingers. When the tobacco is ready to be taken down, the stalks may be still quite green.

METHODS OF APPLYING HEAT.

The importance of heat for good curing in cold or excessively wet weather has been pointed out, but it is equally important that the heat be applied in the right way. Artificial heat has not been utilized to any extent up to the present time in curing filler or binder types, but its use is becoming more general in the wrapper districts, particularly in curing tobacco harvested by priming the leaves.

Small charcoal fires built on the floors of the barn have been in use for some years in Florida and the Connecticut Valley, especially in curing shade-grown tobacco. To secure the proper distribution of heat a large number of fires are required, and but little ventilation should be used during the firing. Charcoal is an expensive fuel, the

supply is often limited and uncertain, and to care for the large number of fires required is quite a task. Without some better or cheaper method, however, charcoal fires should be freely used for curing cigar tobaccos when the weather is unfavorable.

Most woods give too much smoke for use with cigar types. Recent tests with a system of furnaces or flues for introducing heat, in which wood or coal is used as fuel, have given promising results in Connecticut, but this system would be rather expensive for the filler districts.

STRIPPING AND ASSORTING.

As soon as possible after the tobacco is cured, the plants should be taken from the laths and the leaves stripped from the stalk. This can not be done, however, until after damp weather has prevailed long enough for the leaf to become pliable, so that it can be handled readily without breaking. Tobacco in this condition is said to be "in case" or "in order," and weather well adapted to bringing it into case is spoken of as a "tobacco storm." Tobacco will not come into order if the temperature is very low, even when wet weather prevails. If the stalks have been frozen, it is well to leave the plants hanging until the dripping stops, so as to avoid staining the leaf.

Usually, as the plants are taken from the laths they are piled in heaps on a floor of poles or boards, the tips all being turned inward and overlapped to prevent the leaves from drying out. The leaves should be stripped from the stalks as soon as possible after the plants have been taken down, so as to avoid the heaps becoming heated. In some of the filler districts, dampening cellars are used in bringing the tobacco into case, and the plants are taken from the cellar to a sorting room for the stripping. The leaves, as stripped from the stalk, are placed in one, two, or three grades, and those of each grade are tied into "hands" of 15 to 30 leaves, using a leaf as a binder. These hands are packed into cases, and the tobacco is then ready for market, or, the hands are first made into neat bundles or bales by means of a form, wrapped with heavy paper, and tied with twine. These bundles usually weigh from 50 to 100 pounds.

Before the leaf is ready for the manufacturer it must undergo a process of fermentation, commonly spoken of as sweating. To carry out this process successfully requires a thoroughly equipped plant, with facilities for controlling ventilation, temperature, and humidity, so that, as a rule, the growers sell their leaf in the bundle to the packers, who make a business of carrying on the fermentation on a large scale.

CURING SHADE-GROWN AND OUTDOOR-PRIMED WRAPPER LEAF.

In recent years the growing of the Cuban and Sumatra types of cigar-wrapper leaf under artificial shade has become an important industry in the Connecticut Valley and in portions of southern

Georgia and western Florida. In Florida the Cuban types, and more especially the Sumatra tobacco, when grown under ordinary conditions, are frequently harvested by priming, and recently this method has been extensively practiced with the outdoor types of the Connecticut Valley. The barns used are of the same construction as those employed in curing tobacco on the stalk, except that, since the leaves are picked from the stalk in harvesting, the tier poles are only about 2½ feet apart, vertically. All shade-grown leaf is picked from the stalk in harvesting, to insure the maximum yield of high-grade wrappers. Nearly all shade-grown and much of the outdoor primed tobacco is cured in part with artificial heat. Small charcoal fires are made on the floor of the barn and moderate heat is maintained for two or three days or longer, depending on the weather conditions. But little ventilation is given while the fires are going. As soon as the brown color develops, the leaf may be allowed to dry out rather rapidly. The leaf proper cures down in a short time, but a much longer period is required for completely drying out the stems. The picked leaves are subject to pole-sweat at the critical stage, the same as when cured on the stalk, but, of course, the danger period is much shorter. Under favorable conditions the curing will be completed in from four to six weeks. The cured leaf is taken down and tied into hands, which are delivered to the packer in either of the ways described on page 13.

CURING BURLEY TOBACCO.

The bulk of the Burley crop is grown in north-central Kentucky and in a few counties of West Virginia, Ohio, and Indiana bordering on the Ohio River. Like cigar tobaccos, Burley is cured without the use of artificial heat, except when there is danger of injury from pole-sweat or house-burn. There are many types of barns in use for curing Burley tobacco, ranging from the small, crude structure to the most approved modern frame building with ample facilities for controlling the ventilation. The modern barns are essentially the same as those used in the cigar-tobacco districts, which have already been discussed.

MANAGEMENT OF THE CURING.

The method of curing Burley tobacco is the same as for cigar tobaccos, and the changes that take place are of the same kind. When cured, however, the color is a pale yellowish to a reddish brown instead of the characteristic clearer and deeper brown of cigar leaf. If the weather is very dry, the barn should be kept closed during the day and open at night; otherwise, more ventilation is required. If the weather is very damp during the curing period, the leaf cures down too dark. Some growers use small charcoal fires, or burn coke

in stoves to dry out the barn when house burn threatens. From four to six weeks are usually required for completing the curing process.

ASSORTING AND PACKING.

When taken down from the poles the leaves are stripped from the stalk and assorted. The usual grades are (1) flyings, (2) trash, (3) lugs, (4) bright leaf, (5) red leaf, and (6) tips. The three first-named grades are used principally for smoking tobaccos and cigarettes, the best lugs and the bright leaf for plug and cigarette wrappers, and the red leaf and tips for plug and twist fillers. These different grades are tied into hands containing from 10 to 20 leaves and bulked down. For marketing, the tobacco may be packed into hogsheads, but in recent years it has been more and more the practice to sell Burley by the loose-leaf auction system.

AIR CURING IN THE DARK MANUFACTURING AND EXPORT DISTRICTS.

In the large territory immediately west of the Burley district and extending from northern Tennessee through Kentucky into southern Indiana, including the so-called one-sucker and the Green River districts, the tobacco is mostly air cured. The construction of the barn and the management of the curing process are substantially the same as in the Burley district. As a rule artificial heat is not used, but in the Green River district some growers burn coke in long open grates in the barn when unfavorable weather occurs. The cured product is usually assorted into three grades, namely, trash, lugs, and leaf.

The tobaccos grown in Maryland and in eastern Ohio, the greater portions of which are exported, are usually classed together as the Maryland and eastern Ohio export type. Nearly all of that grown in Maryland and much of the eastern Ohio output is air cured. The barns are rather simple affairs, resembling some of the older types used in the Burley and cigar-tobacco sections. The method of conducting the curing is similar to that used in the cigar-tobacco districts when the leaf is cured on the stalk. The tobacco is marketed in hogsheads containing 700 to 800 pounds.

SUN CURING.

In Caroline, Louisa, Hanover, and the adjoining counties of Virginia a type of tobacco is produced which is known as sun cured. This name is based on the fact that formerly the tobacco was exposed to the sun or open air for several days immediately after harvesting, the curing then being completed in the barn without the use of artificial heat. Sun-cured tobacco is used mainly for chewing purposes and exposure to the sun is thought to improve the flavor of the leaf. The same general types of barn are used as are employed in the dark air-cured manufacturing districts.

In typical sun curing, the sticks, filled with the plants, are crowded rather closely together on scaffolds erected near the barn. After the leaves have yellowed, usually requiring four to six days, the sticks are spread farther apart and left on the scaffold a few days longer. The curing is then completed in the barn. If there is much rain during the sunning period the tobacco should be placed under shelter. On account of the increased cost of handling, sun curing is but little practiced now, practically all of the tobacco being cured like Burley and other air-cured types. After stripping, the leaves are usually assorted into but two grades, lugs and leaf, although the best leaves are sometimes placed in a third grade for wrappers.

FLUE CURING.

The distinctive feature of flue curing is that the barn is provided with a system of large pipes which carry off the fuel gases throughout the curing period. The smoke does not come into contact with the tobacco and the cure is completed within a few days. One of the principal factors controlling the value of the leaf cured by this method is the color, and the two prime conditions for success in this respect are the right kind of soil and the proper control of the curing. Nearly all of the flue-cured tobacco, frequently spoken of as yellow tobacco, is produced in southern Virginia, North Carolina, eastern South Carolina, and southern Georgia.

CHANGES IN THE COMPOSITION AND PROPERTIES OF THE LEAF.

In the flue-curing method, just as in the air-curing process, the principal changes in composition must be brought about before the leaf is killed, and the nature of the changes in the two methods is the same. The principal difference lies in the extent or completeness of these changes. The typical bright-yellow tobacco at the time of harvesting is riper than most tobaccos cured without the use of heat. Partly on this account and also because of the character of the soil on which it is grown, this type of leaf is richer in starchy matter and poorer in coloring. Flue curing really consists of hastening and shortening the first stage in air curing, while the second stage of air curing, in which the brown or red color develops, is not allowed to take place at all.

CONSTRUCTION OF THE BARN.

The type of barn used in curing yellow tobacco is comparatively simple in construction and of small size. These barns are generally, but not always, built square and vary from 16 to 24 feet in width, inside measurement. It is necessary that the inside width of the barn be some multiple of 4 feet, since this is the distance between the tier poles, which extend across the barn lengthwise and receive the

sticks on which the tobacco is hung. The first set of tier poles is placed 8 or 9 feet above the ground and each succeeding set 2½ to 3 feet higher. The smaller sized barns are usually built 17 feet high to the eaves and contain four sets of tier poles, while the larger ones are frequently built 20 feet high and contain five or six sets of tier poles. Additional tiers may be placed in the peak.

Flue-curing barns are generally built of logs, but many frame structures have been erected in some sections in recent years, owing to the increasing scarcity of timber. When logs are used the cracks are either chinked with mud or closed with lime mortar. If frame barns are built all cracks should be battened with thin strips of boards or the walls made of two thicknesses of boards with paper be-

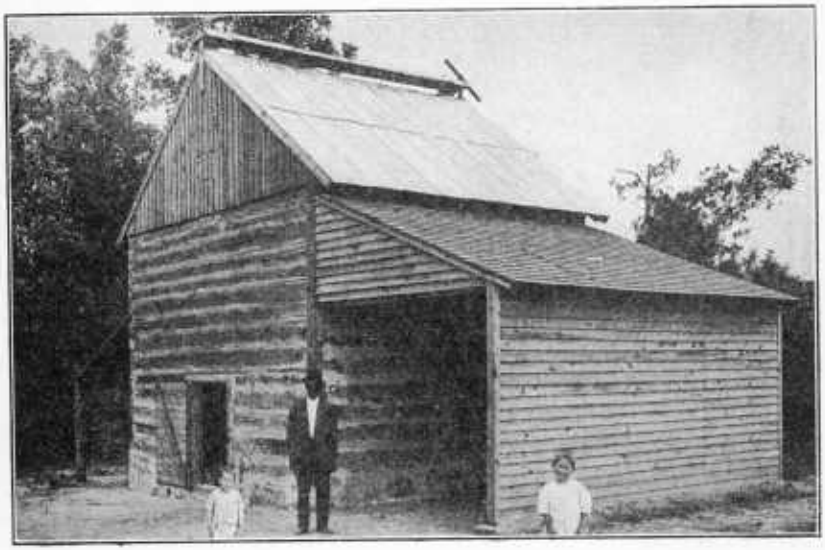

FIG. 2.—Model barn for flue curing tobacco, with good roof ventilator.

tween. Ventilation is usually secured by leaving openings around the bottom of the barn and by cutting small windows in the gable ends near the roof, which can be opened when desired. Many barns contain so many cracks and crevices, especially about the roof, that they require no special ventilators, but such barns are poorly adapted to flue curing. A good type of barn, fitted with an improved roof ventilator, is shown in figure 2.

The heating system consists of a series of sheet-iron flues leading from small furnaces placed at one end of the barn. The arrangement of the flues is comparatively simple, but is variously modified in different sections of the flue-curing belt. One of the best arrangements for the larger sized barns is that shown in figure 3. The furnaces (fig. 3, *F*, *F*) are built of stone or brick and are usually about 18 inches wide and 15 to 20 inches high, inside measurement. The fur-

naces are built from 5 to 10 feet or more in length and project a short way outside. The flues are made in sections similar to ordinary stovepipe and are from 10 to 15 inches in diameter. These flues are fitted into the ends of the furnaces at *A*, *A*, and extend across the barn to *B*, *B*, where they turn at right angles and, continuing to *C*, *C*, they once more turn at right angles and finally pass outward through the wall at *D*, *D*. The flues are inclined slightly upward throughout their length and pass out through the barn wall at a point 1 or 2 feet

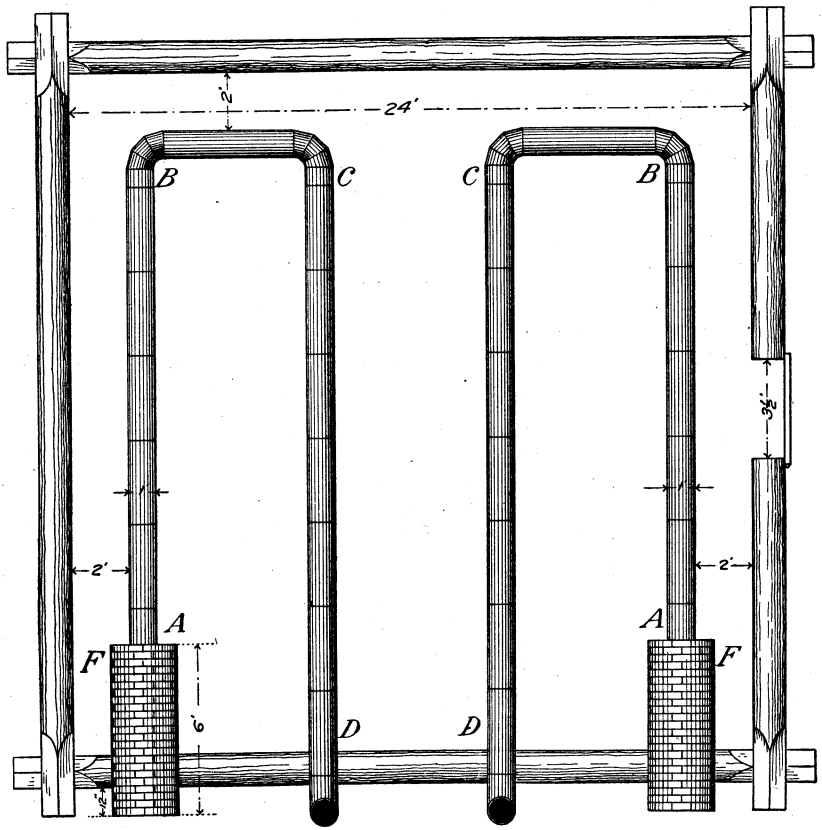

FIG. 3.—Sketch showing the arrangement of furnaces and flues in a flue-curing barn.

higher than the mouth of the furnace. Smokestacks of varying height, the upper ends of which are provided with hoods, are fitted to the outer ends of the flues.

This arrangement of the flues is modified in a variety of ways. The two flues may be united at *C*, *C* (fig. 3), with a single arm returning to the side of the barn from which the furnaces enter, thus giving three lengths of pipe across the barn instead of four. In the smaller barns a single furnace is placed in the center of one end and a single flue leads across the barn and then branches at right angles, each

arm returning along the side walls, thus simply reversing the last described arrangement. Whatever arrangement is used, the flues should not be placed within 18 inches of the walls of the barn.

CONDITIONS AFFECTING THE RATE OF CURE.

There are a number of formulas or rules which are in use in curing yellow tobacco, any of which will give satisfactory results in certain cases. This is due partly to differences in the tobacco when harvested and partly to the fact that all of these formulas are based simply on the temperature in the barn, with scarcely any reference to the humidity, which is really the more important factor in the curing. The principal use of the artificial heat is to regulate the humidity, and evidently this is affected by the amount of water in the tobacco and the prevailing weather conditions.

The capacity of the air for holding moisture, and consequently its drying capacity, depends principally on its temperature, and air which is already saturated has no drying power until its temperature is raised. In order to control the rate of drying, the temperature in the barn must bear a certain relation to that of the outside air, and the correct difference in temperature inside and outside the barn will be influenced by the humidity of the outside air. In warm weather the temperature inside the barn must be higher than in cool weather, and in rainy or wet seasons it must be higher than in dry weather.

In addition to temperature, there is another equally important factor in controlling the humidity in the barn; this is ventilation. The warm, moist air in the barn must be constantly replaced by the less humid outside air; hence, proper means of ventilation should be provided. Few growers fully appreciate the importance of ventilation. Most barns are built without satisfactory provision for ventilation, and the only reason that curing can be successfully done in these cases is that the barns are not sufficiently tight to prevent the natural ventilation caused by the higher temperatures within. Frequently this natural ventilation is insufficient, and at the critical moment the tobacco is badly damaged by discoloration because of the excessive moisture. On the other hand, there are times when it is desirable to check the rate of drying, so that it is important to provide ventilators at the top and bottom of the barn which can be readily opened or closed as desired.

MANAGEMENT OF FLUE CURING.

It is desirable that the barn be completely filled with tobacco in one day. A thermometer is hung on the lower tier, near the center of the barn. Small fires are started in the furnaces and a moderate temperature maintained until the leaf is thoroughly yellowed, re-

quiring from 24 to 36 hours. The yellowing may be accomplished at any temperature between 80° and 120° F. It is well to start at 80° or 90° F., and gradually raise the temperature up to 110° or 120° F. at the completion of the process. The change from a green to a yellow color, along with other necessary changes, takes place chiefly while the leaf is still living, and at temperatures above 120° F. the leaf is rapidly killed, so that this limit must not be exceeded during the yellowing process. Care must be taken to avoid drying the leaf too rapidly at the beginning, but as it begins to yellow, the humidity in the barn must be decreased by slowly raising the temperature and gradually increasing the ventilation.

The completion of the yellowing process ends the first stage of the curing, and then begins the critical period, commonly spoken of as "fixing the color." The object at this stage is to remove the moisture as fast as it is given off by the leaf, and plenty of ventilation is essential to success. If the leaf still contains very much moisture when the yellowing has been completed, splotches of red or brown will soon begin to appear on the surface. This trouble, caused by insufficient ventilation toward the end of the yellowing, is known as "sponging." It is often too late to correct the trouble at this stage, but more ventilation may prove beneficial. If the heat is increased too rapidly while the leaf is still full of sap, a greenish black color will develop, which is known as "scalding" or "blistering." The best results are obtained when the temperature is gradually increased throughout this phase of the curing until 130° to 135° F. is reached. Some growers follow the practice of raising the temperature rapidly to 125° F. or more and then quickly lowering the temperature and opening the door and ventilators, which process is repeated several times. This method is simply another way of removing the excessive moisture, and is unnecessary if the barn is properly provided with ventilators.

The temperature should be maintained at from 130° to 140° F. until the leaf is completely dried out, which will require from 10 to 18 hours after the completion of the yellowing process. All danger from sponging or scalding will then be past, and it will be necessary only to dry out the stems. The ventilators should be nearly closed and the temperature raised to 165° or 170° F. at the rate of about five degrees an hour. This temperature is maintained till all stems are completely dried out. Some growers raise the temperature to 190° or 200° F., and even higher, but this greatly increases the danger of burning up the barn and contents, an accident which is by no means rare. These high temperatures cause the leaf to take on a reddish cast and the process is known as "scorching." When the tobacco is harvested by cutting the stalk instead of picking the individual leaves, the final stage of drying must be prolonged for 24 to 48 hours in order to remove all moisture from the stalks.

When the tobacco is to be taken down, the barn is left open during the preceding night, and the floor may be sprinkled, if necessary, so that the leaf may absorb sufficient moisture to bring it into condition for handling. If the leaf can be folded in the hand without breaking the stem it is in proper condition to be taken down without injury.

ASSORTING AND HANDLING.

When taken down, the tobacco is placed in bulks in shingle fashion without removal from the sticks. In order to avoid injury from mold, the bulks should be torn down at the end of a week or 10 days and rebuilt with all the butts pointing outward and the tips overlapping in the center. This treatment greatly improves the color of the leaf and especially assists in bleaching out the green remaining after the curing. It frequently happens that the contents of a barn showing a decided greenish cast will come from the bulk with a clear lemon-yellow color, provided the green has not been set by drying out the leaf too rapidly in the first stage of the curing.

When the bleaching process has been completed the leaves are carefully assorted into from 6 to 10 grades, based mainly on color and freedom from holes or spots. Yellow tobacco is classified on the market into (1) wrappers, consisting of the most nearly perfect leaves; (2) cutters, being leaves deficient in body and inferior to wrappers; (3) smokers, consisting of bottom or sand leaves and others bruised or torn and lighter in body than cutters; and (4) fillers, being all tobacco not included in wrappers, cutters, or smokers. Each of these four classes is subdivided into two or more grades. The finest grade of wrappers is bright lemon yellow in color and composed of leaves free from imperfections and possessing sufficient toughness and elasticity. The next best grade is orange yellow in color, and then comes the light reddish brown grade, known as mahogany wrappers.

Market prices are greatly influenced by the care and skill used in grading yellow tobacco, and this work requires experience and the ability on the part of the assorter to classify colors accurately. Each grade is tied into small bunches, or hands, and the leaf is then ready for market. In recent years much of the tobacco in the eastern section has been sold as loose leaf, without grading.

FIRE CURING.

The use of open fires in curing is confined mostly to those sections growing the export types. The principal areas producing these types are embraced in something over 20 counties of central Virginia, the Clarksville and Hopkinsville district, the Henderson district, and the Paducah district, the last three districts all being included in that portion of Kentucky and northern Tennessee west of the dark air-cured manufacturing districts of these States. Fire-cured export

tobacco is also produced in four or five counties of eastern Ohio near the West Virginia line.

The old type of barn used for curing export tobacco is built of logs, the cracks being daubed with mud. These barns are of small size, but are generally built high enough to contain five sets of tier poles. In recent years the log barns have been partly replaced by more modern frame buildings of much larger size, which are provided with large doors opening into passageways leading through the building, thus allowing a loaded wagon to be drawn directly beneath the tier poles. These poles are arranged at intervals of about 3 feet 10 inches horizontally and 3 feet vertically, the first set of poles being 8 or 9 feet above the ground. A type of barn in use in Kentucky and Tennessee is shown in figure 4.

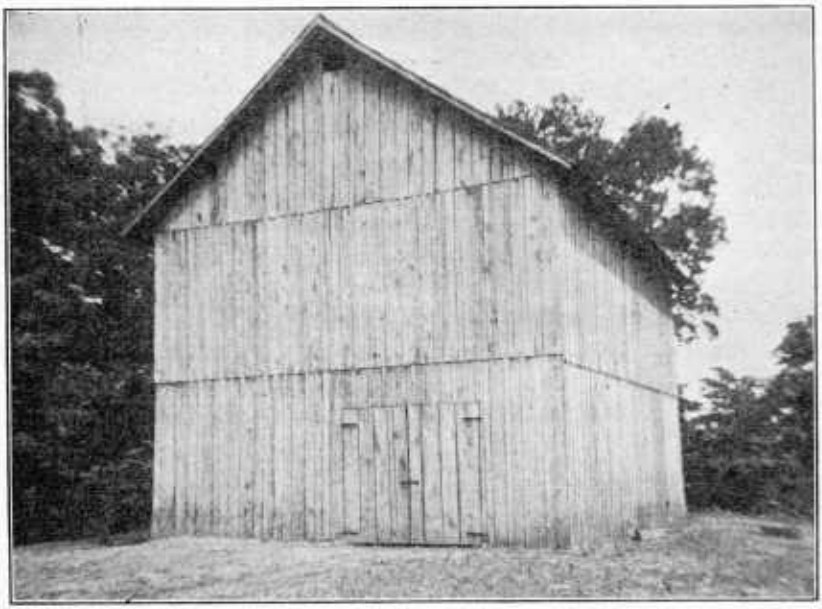

FIG. 4.—A type of barn used in the fire-cured tobacco districts of Kentucky and Tennessee.

MANAGEMENT OF THE CURING.

Usually no heat is required during the first stages of yellowing, for if applied at this stage the leaf would dry out too rapidly. It is important to avoid this drying out of the leaf before the proper colors have been developed and other important changes brought about. From three to five days after harvesting, slow fires are started on the floor of the barn and the temperature maintained at 90° to 95° F. until the yellowing of the leaf has been completed. As soon as this is accomplished the temperature may be slowly increased till 125° or 130° F. is reached and held at this point till the leaf tissue is pretty well dried out. Altogether, the fires are kept up for from three to

five days. Formerly it was the general practice to stop the fires when the leaf had begun to dry and allow it to soften by the flow of sap from the stem and by absorbing moisture from the air. The fires were then started again and the process of alternate drying and softening continued until the curing was complete. This practice is not so common now as formerly. The smoke from the open fires imparts a characteristic odor and taste to the tobacco and improves its keeping qualities.

During the first stages of the curing, when the tobacco is still full of sap, too much heat must be guarded against or portions of the leaf will be discolored by "scalding," as in the case of flue curing yellow tobacco. Until the leaf is pretty well dried out, house-burn must be guarded against, and, if necessary, the fires should be started earlier, when more ventilation is required. After the curing has been completed, slow fires should be started during periods of wet weather to prevent injury to the leaf from molds and also to prevent too much darkening of the color. Frequently the tobacco is improved by bulking it down without removing it from the sticks, as already described for yellow tobacco.

In the northern portion of the Virginia fire-cured district, which is known as the olive-green stemming district, the method of curing is modified, as tighter barns are used and high heat is applied from the outset, the curing being completed in about two days. The object is to obtain a dark-green or almost black color without allowing the leaf to yellow. This type is strongly smoked during the curing.

STRIPPING AND ASSORTING.

When the thoroughly cured tobacco has become pliable by the absorption of moisture during a damp season, the plants are removed from the sticks and the leaves stripped off. Three principal grades are usually made, known as trash, lugs, and leaf. The leaf grade is further subdivided into several grades based on size of leaf and color. The several grades are tied into neat bundles containing six to eight or more leaves. In the Virginia fire-cured district the tobacco is sold loose by the auction system, and this method of marketing has recently gained ground in the western districts where formerly it was the general practice to pack or "prize" the leaf in hogsheads. Tobacco packed in hogsheads is sold by sample, so that careful assorting and packing are necessary if the highest market prices are to be obtained. Tobacco in condition for winter handling will not keep through the spring, but will mold when warm weather sets in unless it is reordered by again hanging it up to dry out. It is then ready for taking down and packing in favorable weather and will keep indefinitely.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

June 6, 1924.

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